# CHAPTER FOUR

# CURRENT MANAGEMENT PRACTICES FOR CKD

## 4.0 INTRODUCTION

Four general approaches are used in managing CKD at cement plants: direct recycling, treatment and return to the kiln system, landfilling/stockpiling, and/or off-site use. As discussed in Chapter 3, direct recycling of CKD to the raw feed is preferable when practical; however, excessive alkali content, as well as other operational factors, may limit this practice.[1] Dust that is removed from the system may be disposed in waste management units (WMUs) or sold or given away for beneficial use off site.

This chapter describes current management practices for CKD that is not recycled to the kiln -- that is, it is removed from the kiln system. The first section discusses on-site land disposal of CKD, including the three major types of WMUs. The potential environmental impacts of on-site disposal of CKD, including potential exposure pathways and environmental protection practices at WMUs, are examined in the second and third sections. Finally, in the last section, the off-site beneficial uses of CKD are described.

## 4.1 ON-SITE LAND DISPOSAL

Waste CKD is most commonly land-disposed in on-site WMUs. Respondents to the 1991 PCA Survey (representing usable data from 79 plants and 145 kilns) reported that they land disposed an average of about 33,000 metric tons of CKD per plant in 1990. Of this aggregated average, wet process facilities disposed of 41,735 metric tons per plant and dry process facilities disposed of 27,419 metric tons per plant. Extrapolating these averages for wet and dry kilns to the entire industry, an estimated 4.2 million metric tons of CKD were land disposed nationwide in 1990.

Of 81 facilities responding to the 1991 PCA Survey, 62 (77 percent) indicated that they manage CKD on site (no off-site CKD WMUs have been reported). Only two of the respondents indicated that they had more than one active WMU. All but one of the facilities in the sample having a wet kiln disposes of CKD on site, and the net CKD from about two thirds of the wet kilns is sold for off-site use. CKD is disposed at somewhat more than half of the dry kilns with preheaters/precalciners. CKD from all but four of the 32 kilns burning hazardous waste is disposed on site, while the CKD from 66 of 93 kilns not burning hazardous waste is so managed. Some facility operators view CKD placement in waste management units as temporary stockpiling rather than disposal, with the expectation that the CKD will ultimately be removed for beneficial utilization. The 23 percent of facilities that do not dispose CKD in WMUs are those that recycle all of their CKD, or sell all of their net CKD.

The 1991 PCA Survey defined land disposal units for CKD as being comprised of three general types: landfills, piles, and ponds. Ninety-seven percent of the respondents with WMUs classified their units as one of these three types. Three percent of the responses, or two facilities, indicated that they managed CKD using a slight variation of these types.

### 4.1.1 Landfills

At cement production facilities, landfills are reportedly the most common on-site management method. Landfills accounted for 52 percent of the WMUs in the survey responses. Landfills are generally defined as WMUs in which material is disposed below the topographic grade and is sometimes buried between layers of earth. Usually landfills are artificial structures

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[1] In this case, CKD can be treated using various methods to remove alkalies and can then be recycled to the kiln system. These methods are described in Chapter 8. When in-plant closed loop recycling has reached its practical limit, CKD must be removed from the system.

equipped with an engineered liner and a leachate/run-off collection system. For CKD disposal, however, landfills are generally not engineered structures; that is, they generally were not constructed in the manner that current solid waste landfills are constructed, with liners or run-off collection systems. CKD is typically dumped into a retired portion of the existing limestone quarry or in a nearby ravine. The CKD is either transported by truck to the quarry, pumped as a slurry, or insufflated through pipelines. In a typical operation, CKD is transported by truck to the quarry where it is dumped at the edge. The dust typically remains where dumped for a period of weeks or months to "weather," after which it is bulldozed over the edge into the quarry.

As an example, the River Cement plant in Festus, Missouri transports pelletized waste dust to its on-site CKD monofill. The monofill is located in a ravine that the facility has reportedly closed off with an earthen berm at its base. Once at the monofill, the CKD is bulldozed into a desired location.

### 4.1.2 Piles

With a slightly lower count than landfills, 43 percent of the WMUs in the survey responses were reported as piles. Like landfills for CKD, piles also are not engineered structures but are instead accumulations of CKD in designated areas. Such piles may or may not be above grade, and they may or may not be contained within the quarry. EPA believes that there was probably little differentiation between piles and landfills from the perspective of the respondents to the survey.

For example, the Ash Grove Cement plant in Inkom, Idaho, prior to installing a CKD dust leaching system approximately 20 years ago, disposed waste CKD in several large piles at the edge of the facility's limestone quarry. The piles have since been covered with shale, and during a May 1993 sampling visit attended by EPA personnel, vegetation was observed growing on many of the pile surfaces. During another sampling visit conducted in May 1993 at the Keystone Cement plant in Bath, Pennsylvania, EPA personnel observed several large CKD piles that had accumulated on open ground adjacent to active cropland.

### 4.1.3 Ponds

Disposal ponds at cement plants are different from landfills and piles in that CKD is stored underwater. This is an unusual WMU type and only one of the survey respondents indicated that it managed CKD in this manner. However, the Holnam Incorporated cement plant in Artesia, Mississippi has constructed an active CKD pile along the edge of an inactive limestone quarry, which has filled with water to form a lake. During a May 1993 sampling visit to the facility attended by EPA personnel, the active CKD pile was observed extending into the lake. The active pile will be extended further into the lake as more CKD is added.

Use of ponds creates a permanent hydraulic head on the dust, which imposes a continuous downward pressure and creates the potential for downward migration of contaminants into ground water. Additional discussion of this type of WMU and its implications for environmental and human health risk may be found in Chapter 6.

### 4.1.4 Dimensions

The size of CKD waste management units can vary considerably, depending upon such factors as unit type, age, and the quantity of dust discarded. The 1991 PCA Survey responses generally did not provide clear data on the volume of CKD contained in the waste management units. However, unit thickness and basal area measurements were reported, and these are presented in Exhibit 4-1. The information available from the survey is insufficient to calculate total volumes, because unfounded assumptions of uniform unit geometry (e.g., a cylindrical or rectangular shape) would provide inaccurate results.

As shown in Exhibit 4-1, piles tend to be the largest units, attaining a maximum height or thickness of 56.4 meters (m) (185 feet), according to usable responses to the survey, and averaging 15 m in thickness or height. Landfills average 14 m in thickness, with a maximum reported thickness of 34.6 m. The landfill units averaged twice the basal area of the piles, at approximately 7.9 hectares (19.4 acres), compared to about 3.6 hectares for the piles. These units can occupy significant land areas, covering up to 54.2 hectares. The pond and the "other" units are very small in comparison in basal area.

**Exhibit 4-1**

**1991 CKD Waste Management Unit Dimensions**

| CKD Waste Management Unit Type | # WMUs With Usable Responses[a] | Thickness (meters) | | | Basal Surface Area (hectares) | | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Avg. | Min. | Max. | Avg. |
| Pile | 18 of 28 | 3.05 | 56.4 | 15 | .04 | 8.4 | 3.8 |
| Landfill | 15 of 34 | 4.3 | 34.6 | 14 | .19 | 54.2 | 7.9 |
| Pond | 1 of 1 | 3.7 | 3.7 | 3.7 | .36 | .36 | .36 |
| Other | 1 of 2 | 24.7 | 24.7 | 24.7 | .03 | .03 | .03 |

[a] Based on usable responses to the 1991 PCA Survey.

### 4.1.5 Codisposal

Facility operators also use land disposal units for small quantities of materials other than CKD. Information provided in the PCA Survey responses indicated that, the 66 CKD WMUs, 23 percent contained non-CKD waste materials in addition to CKD. These materials, totalling 22,333 metric tons, include furnace brick, concrete debris, and tires, and constitute less than one percent of the material reporting to disposal in these units in 1990. The quantity of quarry overburden co-disposed with CKD in 1990 nearly equalled CKD disposal quantities in 1990. This material, because of its earth-like nature, was not considered a "waste material" when performing this analysis.

### 4.1.6 Remaining Useful Life

As facility operators continue to land-dispose CKD, the available capacity of existing waste management units will decrease. The 1991 PCA Survey responses yielded data regarding the remaining useful life of WMUs. Exhibit 4-2 provides a breakdown of these data in 10-year intervals. Of the 53 respondents with usable data, most (55 percent) of the CKD WMUs will be full to capacity within the next 20 years.

**Exhibit 4-2**

**Remaining Life of Waste Management Units[a]**

| Remaining Useful Life (Range in Years) | Number of CKD Waste Management Units | Percent of CKD Waste Management Units[b] |
|---|---|---|
| 0-9 | 13 | 24.5 |
| 10-19 | 16 | 30.2 |
| 20-29 | 9 | 17.0 |
| 30-39 | 1 | 1.9 |
| 40-49 | 5 | 9.4 |
| 50-59 | 3 | 5.7 |

| | | |
|---|---|---|
| 60-69 | 1 | 1.9 |
| 70-79 | 0 | 0.0 |
| 80-89 | 0 | 0.0 |
| 90-99 | 1 | 1.9 |
| 100-109 | 3 | 5.7 |
| 200-209 | 1 | 1.9 |
| Total | 53 | 100 |

[a] Based on usable responses from 1991 PCA Survey

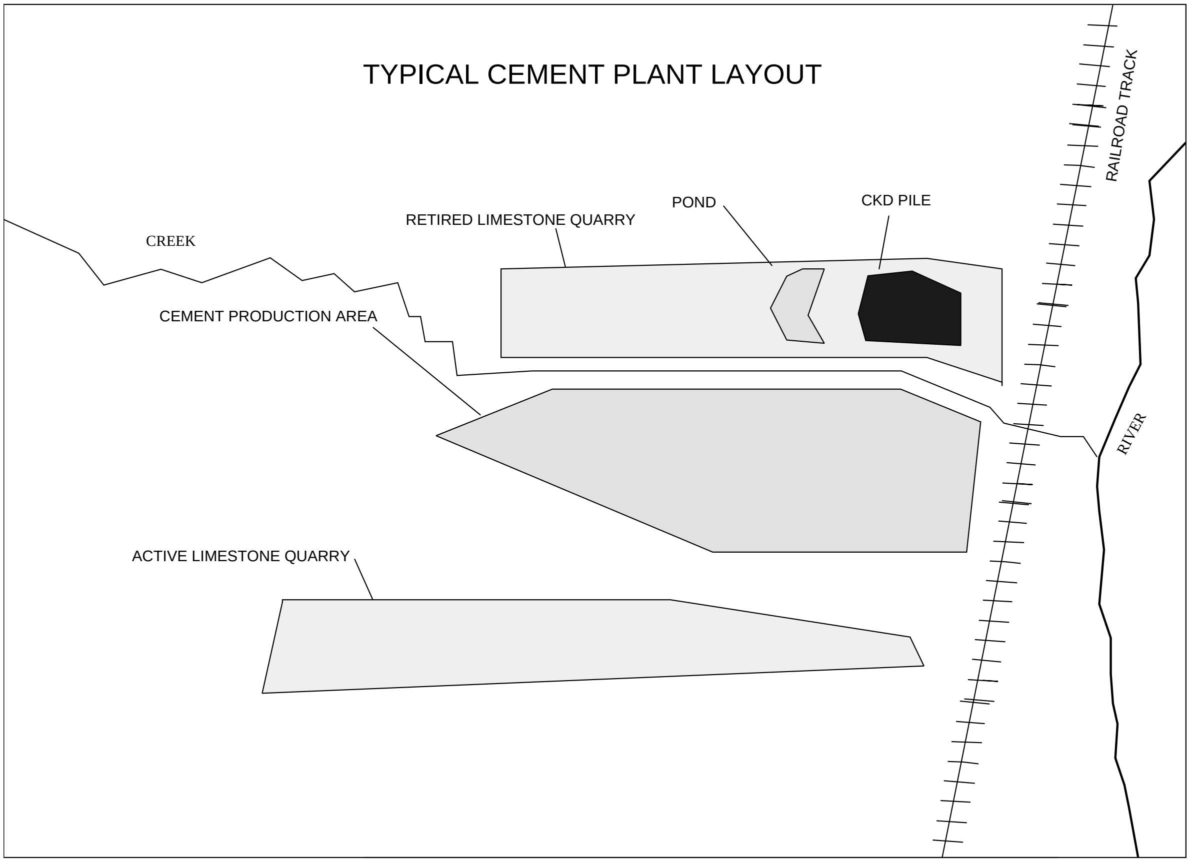
[b] (# CKD WMU's in a given range / Total # CKD WMU's ) x 100

## 4.2 POTENTIAL EXPOSURE PATHWAYS

CKD management practices may affect human health and the environment through three primary exposure pathways: ground water, surface water, and air. The potential for release to these media varies according to the CKD management practices and the control measures employed at a given facility. This section introduces the mechanisms by which CKD constituents are released to each medium, while Chapter 6 evaluates the human health and environmental risks associated with the different release and exposure pathways. Exhibit 4-3 presents a layout of a typical cement plant that illustrates potential exposure pathways. At a typical facility, a surface water body runs past the facility, while CKD is managed in a waste management unit in a retired quarry that is near ground-water level.

**Exhibit 4-3**

**Typical Cement Plant Layout**




### 4.2.1 Ground Water

Precipitation may percolate through CKD and leach constituents into the liquid phase. Based on the constituents' tendency to remain bound up in the matrix of the waste (i.e., the mobility of the constituents and their solubility in water), they may then migrate through the vadose zone (i.e., unsaturated zone) and enter an underlying aquifer. After release to ground water, the constituents will move with the general flow of the ground water, although at a velocity that is slower than the ground water itself depending on their individual tendencies to bind to soil. Exposure to ground-water contaminants can occur through the domestic use (e.g., drinking water source) of untreated ground water. Potential migration to ground water is a particular concern when CKD is managed underwater, such as in surface impoundments or flooded quarries. The standing water column in these types of waste management units exerts a downward pressure (hydraulic head) that forces water through the vadose zone to the ground water.

For CKD management, ground water may be a potential exposure pathway because several CKD constituents (e.g., arsenic) are particularly mobile in ground water under high-pH, a condition associated with CKD leachate. In addition, many of the facilities are underlain by shallow aquifers, and only a few facilities have control measures in place to prevent or detect the migration of CKD leachate. Such control measures include the installation of synthetic or natural (e.g., compacted clay) liners, installation of leachate detection/collection systems, capping CKD management units to prevent leaching by precipitation, and installation of slurry walls to prevent lateral ground-water migration.

### 4.2.2 Surface Water

Stormwater run-off from a waste management unit is an important release mechanism, as precipitation may carry constituents in either a dissolved or suspended form through natural flow patterns to nearby surface waters or farm fields. Flooding or overflow of submerged WMUs may also result in CKD constituents being released to streams and rivers. In addition, constituents of concern may be released to surface water by migrating through ground water that discharges to a surface water body.

Human and ecological receptors may be exposed to surface water contamination through various means, including drinking water intake, ingestion of contaminated fish or shellfish, and direct contact with contaminated water. Common practices for controlling releases[2] to surface water include the leachate controls as described above for ground water; stormwater run-on/run-off controls that divert water from piles on landfill areas and/or collect run-off from the WMU for treatment prior to release to surface waters; and capping or covering.

### 4.2.3 Air

CKD constituents can be released to the air in the form of a gas or a particle. The only constituents that can be released as a gas are volatile or semivolatile organic chemicals (e.g., benzene and toluene), which tend to be present in relatively low concentrations in CKD, if present at all. Most CKD constituents (e.g., metals) are not volatile but could be released to air through fugitive dust emissions. Dust particles may be suspended in the air by either wind erosion or mechanical disturbances. The extent to which dust is blown into the air by wind erosion depends on a number of site-specific characteristics, including the texture (particle size distribution) and moisture of CKD on the surface of piles, the presence of nonerodible elements such as clumps of grass or stones on the pile, the existence of a surface crust, and wind speeds. Mechanical disturbances that can serve to suspend CKD constituents in the air include vehicular traffic on and around CKD piles, CKD dumping and loading operations, and transportation of CKD around a plant site in uncovered trucks. Cement plants may use a variety of control measures to limit the release of CKD to the air.[3] For example, CKD may be "nodulized" in a pug mill, compacted, wetted, covered, and/or mixed with large chunks that are not susceptible to wind erosion.

CKD constituents that are released to the air are transported and dispersed by the winds and eventually deposited onto land or water, either by settling in a dry form or by being entrained in precipitation. Humans and other organisms can be exposed to the constituents in a number of ways. For example, airborne particles that are equal to or smaller than 10 micrometers (μm) in size are respirable and may be inhaled directly. Contaminants that have settled onto soil may be incidentally taken into the mouth and ingested, and contaminants that have been deposited on vegetation may be ingested via the food chain. In the specific case of radionuclides, people may be exposed to direct radiation emanating from radionuclides in the air or deposited onto the ground.

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[2] Stormwater controls and other regulatory requirements addressing releases to surface waters are described in Chapter 7.

[3] Plant-specific air pollution control permits often explicitly address fugitive dust emissions from CKD piles and other sources. A more complete discussion of this topic is presented in Chapter 7.

## 4.3 ENVIRONMENTAL PROTECTION PRACTICES

As noted above, CKD WMUs can represent permanent placement of a large volume of material that extends over a significant area. Because CKD disposal units are generally uncovered, they are subject to all of the climatic conditions of the geographic region in which they are located. Precipitation events are notable because they can transport particles and solubilized constituents beyond the boundaries of the WMU. Gusting winds are another potential transport mechanism.

To reduce the potential for off-site migration of CKD and CKD constituents, facilities managing CKD in WMUs can employ various environmental protection practices. These include run-off control/collection, run-off collection/treatment, leachate control/collection, leachate collection/treatment, slurry walls, liner systems, dust suppression, dust compaction, ground-water monitoring, and the preparation and implementation of closure plans. Exhibit 4-4 displays these practices as reported for 66 WMUs at the 62 facilities responding to the PCA Survey for which usable data were available. To relate these data to analyses presented in previous sections, EPA has classified WMUs by those receiving CKD from kilns burning hazardous waste and those receiving CKD from kilns not burning hazardous waste. Although statistical conclusions are tenuous given the small number of observations in some cases, Exhibit 4-4 reports the frequencies of each practice as both number and percentage of WMUs in the respective fuel use category. It should be noted that a single WMU may employ several of the listed environmental protection practices.

*Run-off control/collection* involves diverting precipitation away from the WMU to a discharge area (e.g., a stream) or into a collection unit (e.g., a treatment impoundment) or directly to a receiving stream. As presented in Exhibit 4-4, about 50 percent of both kilns burning hazardous waste and those not burning hazardous waste perform some type of run-off control. The diverted run-off is typically either discharged directly to a surface water stream, or discharged after some form of treatment. Existing treatment methods are unknown, though over 20 percent of the WMUs possess systems that reportedly treat collected run-off.

*Leachate controls* are any devices or approaches (e.g., underdrains) to prevent aqueous liquid that has entered managed CKD from exiting the WMU in an uncontrolled manner, particularly to the ground water. Overall, about 18 percent of the WMUs have leachate control, while about half that number also treat the leachate in some manner. This practice is more prevalent among the facilities not burning hazardous waste; 10 of 50 WMUs in this category have leachate controls, while only two of 16 WMUs containing CKD from hazardous waste-burning kilns are so equipped.

*Slurry walls* are very low-permeability walls cast-in-place in trenches of varying depth and width around a waste management unit. This technology is one of the more costly environmental control measures, and is reported at only nine of the 66 WMUs (approximately 15 percent) overall. Seven of these nine are WMUs receiving CKD from hazardous waste burners, while only two (representing four percent) of the WMUs from kilns not burning hazardous waste have such devices.

**Exhibit 4-4**

**Environmental Protection Practices at CKD Waste Management Units Active in 1990, by Kiln Fuel Use Type**

| Environmental Protection Practices[a] | All Fuel Types | | Hazardous Waste Burners | | Not Hazardous Waste Burners | |
|---|---|---|---|---|---|---|
| | No. of WMUs | Percent of WMUs[c] | No. of WMUs | Percent of WMUs | No. of WMUs | Percent of WMUs |
| Run-off Control/Collection | 34 | 51 | 8 | 50 | 26 | 52 |
| Run-off Collection/Treatment | 15 | 22 | 4 | 25 | 11 | 22 |
| Leachate Control/Collection | 12 | 18 | 2 | 13 | 10 | 20 |
| Leachate Collection/Treatment | 5 | 8 | 1 | 6 | 4 | 8 |
| Slurry Walls | 9 | 14 | 7 | 44 | 2 | 4 |
| Modified Natural Liner | 7 | 11 | 1 | 6 | 6 | 12 |
| Dust Suppression | 29 | 44 | 9 | 56 | 20 | 40 |
| Dust Compaction | 22 | 33 | 6 | 38 | 16 | 32 |
| Other | 14 | 21 | 3 | 19 | 11 | 22 |
| Ground-Water Monitoring | 11 | 17 | 4 | 25 | 7 | 14 |
| Closure Plan (Approved) | 10 | 15 | 3 | 19 | 7 | 14 |
| Closure Plan (Not Approved) | 2 | 3 | 1 | 6 | 1 | 2 |
| None | 26 | 39 | 5 | 31 | 21 | 42 |
| Total in Response Group[b] | 66 | | 16 | | 50 | |

[a] A WMU and/or a facility may have more than environmental protection practice.

[b] Based on 81 usable facility responses to 1991 PCA Survey, 62 facilities of which had active WMUs in 1990.

[c] Calculated as number of WMUs in a fuel-type column for the relevant environmental protection practice divided by the total WMUs for that fuel type. For example: 8 WMUs from hazardous waste burners practice run-off control/collection, divided by 16 total WMUs from hazardous waste burners, equals 50 percent.

*Liners* may be used in a WMU to restrict leachate from entering permeable soil layers and underlying ground-water aquifers. Liners can be natural or synthetic. Examples of natural liners are the indigenous bedrock or *in-situ* clay/shale. Natural liners can be modified through compaction to reduce downward migration channels. Synthetic liners may include compacted clay/shale, asphalt, concrete, or a manufactured woven fabric. Twenty-two percent of the respondents to the 1991 PCA Survey who have WMUs indicated that liners are not used. Of the 78 percent of respondents who indicated that they did use liners in their WMUs, none reported use of synthetic liners. This information is in accordance with EPA's observations during site visits, which revealed that all WMUs visited had only natural liners, typically the bedrock within a retired portion of a limestone quarry. As shown in Exhibit 4-4, seven (about 11 percent) of the respondents across both fuel types stated that they used modified natural liners.

*Dust suppression/control* is defined in the 1991 PCA Survey as any means of reducing the level of ambient breathable dust. Controls under this practice can include wetting, compacting, or covering CKD. Almost half of the WMUs across both fuel types reportedly have some form of dust control system. *Dust compaction* involves the densification of waste material to increase available disposal space and ameliorate dust migration. About 30-40 percent of the WMUs of both fuel types reportedly undergo some type of dust compaction.

Respondents to the *"other"* category indicated methods used to cover or contain a CKD WMU (soil cap, clay cap, berm, rip-rap cap, tree planting, etc.). Such activities were reported for about 20 percent of units, both within and across fuel types.

Overall, approximately 17 percent of WMUs have some type of *ground-water monitoring* system. In absolute terms, more non-hazardous waste burners (seven) monitor ground-water quality than hazardous waste burners (four), though in percentage terms, nearly twice as many hazardous waste burners in the sample of 66 monitor ground water as non-hazardous waste burners (25 percent vs. 14 percent).

In general, *closure plans* do not appear to be significantly more common for WMUs at hazardous waste-burning facilities than for WMUs at facilities that do not burn hazardous waste. Ten of the twelve units addressed by a closure plan have been approved by the pertinent regulatory agency.

Finally, 39 percent of the WMUs have none of the environmental controls listed in Exhibit 4-4; this finding applies to 31 percent of WMUs from hazardous waste-burning facilities, and to 42 percent of the facilities not burning hazardous waste. Since, however, the quality and effectiveness of reported systems is unclear, it is difficult to assess what, if any, increased exposure risks might exist at these WMUs compared to WMUs that do utilize environmental protection practices. As mentioned above, the implications of the use or lack of use of various environmental protection practices is discussed in greater detail in Chapter 7.

## 4.4 BENEFICIAL USE OF CKD

When CKD is not put back into the kiln or disposed on site, a facility may sell it for off-site beneficial use. EPA's data regarding beneficial uses of CKD came from two sources, the 1991 PCA Survey and cement facility responses to EPA's 1992 request for information under RCRA section 3007. Besides information on the beneficial uses of CKD, the PCA Survey data included information on gross and net CKD generation rates, kiln type, and fuel type. The §3007 responses contained information on beneficial uses of CKD, but did not include that other information. Some facilities submitted both the 1991 PCA Survey and a response to the §3007 request for information, however, there were other facilities that only sent a response to the section 3007 request. Therefore, only 1991 PCA Survey data were used to relate off-site use to generation rates, kiln type, and fuel type. The aggregated data were used to calculate percentages of CKD sold (or given away) for off-site beneficial uses.

Of the approximately 9.8 million metric tons (9.4 million tons) of CKD generated from 145 kilns at 79 plants providing usable responses in the 1991 PCA Survey, approximately 6.5 percent of gross CKD was sold off site or given away for beneficial use by 44 facilities. Responses to EPA's 1992 RCRA §3007 request indicate that at least 15 additional plants sold or gave away CKD in 1990. Respondents to the 1991 PCA Survey sold (or gave away) an average of 3,920 metric tons of CKD per kiln in 1990, representing 5.8 percent of the gross CKD. Of this aggregated average, wet kilns sold 7,833 metric tons per kiln and dry kilns sold 1,866 metric tons per kiln, accounting for 13.3 percent and 2.6 percent of gross CKD. Of the dry kilns, dry long kilns sold or gave away 1,993 metric tons per kiln (2.8 percent of gross CKD) and dry kilns with preheaters/precalciners sold 1,721 metric tons per kiln (2.3 percent of gross CKD). Wet kilns sell or give away a higher average percentage of their gross CKD than dry kilns. When considering fuel type, there is no apparent link between fuel type and percent of gross CKD sold or given away. Dry kilns that burn hazardous waste sell or give away a higher percentage of gross CKD than dry kilns that do not burn hazardous waste. On the other hand, wet kilns that do not burn hazardous waste sell or give away a higher percentage of gross CKD than wet kilns that burn hazardous waste.

The primary end-use applications for CKD sold off site as categorized in the 1991 PCA Survey were waste stabilization, soil amendment (both as a soil stabilizer and as a fertilizer), liming agent, materials addition, road base, and "other." Exhibit 4-5 below provides survey and §3007 data regarding end-use applications for CKD sold off site. As shown in the exhibit, 71 percent of the approximately 0.94 million metric tons of CKD sold off site in 1990 was used for waste stabilization. Soil amendment accounts for the second largest use, approximately 12 percent. The category "other" includes uses such as wet scrubbing or general undefined agricultural use. These categories are briefly discussed below. More detailed discussion of both these current and potential beneficial utilizations of CKD may be found in Chapter 8. In addition, researchers have investigated using CKD in other applications, including as an ingredient in livestock feed, as a lime-alum coagulant, as a mineral filler, as an ingredient in the manufacture of lightweight aggregate, and as a replacement for soda ash in the manufacture of green glass.

### 4.4.1 Waste Stabilization

Waste stabilization was, by far, the most common beneficial use of CKD, accounting for just under 71 percent of the total in 1990 (see Exhibit 4-5). CKD can absorb excess liquids and provide an alkaline environment to neutralize acids. Through its absorption capacity, CKD can dewater contaminated materials to increase weight-bearing capacity and to reduce the presence of free leachate. One of the primary forms of waste stabilization for which CKD is used is for municipal sewage treatment sludge. It is an economical and effective means of dewatering and stabilizing raw or digested sewage treatment sludges, thereby rendering such sludges more conducive to handling. The treated sludges can then be used as landfill cover, structural fill material, dike construction material,

**Exhibit 4-5**

**Estimated Off-Site Uses for CKD Sold/Given Away[a]**

| Off-Site Uses of CKD | Quantity (Metric Tons) | % of Total Off Site[b] | # Facilities Burning HW | # Facilities Not Burning HW |
|---|---|---|---|---|
| Total CKD Sold/Given Away 1990 | 940,000 | 100.0 | 16 | 47 |
| Used for Waste Stabilization | 668,274 | 70.8 | 15 | 35 |
| Used as Soil Amendment | 110,676 | 11.7 | 1 | 13 |
| Used as Liming Agent | 52,480 | 5.6 | 1 | 5 |
| Used for Materials Addition | 25,365 | 2.7 | 0 | 3 |
| Used as Road Base | 10,832 | 1.2 | 0 | 4 |
| Other | 75,840 | 8.0 | 0 | 13 |

[a] The information in this table was estimated from the 1991 PCA Plant Information Summary, the 1991 PCA Surveys returned by 88 facilities and the responses of 85 facilities to the EPA's 1992 request for information under RCRA section 3007. The data obtained thereby address 109 facilities. The data in this table were extrapolated to the industry as a whole, i.e., from 109 to 115 facilities.

[b] (tons used off site for given use/total tons used off site) x 100

and in agricultural applications.[4,5,6,7] Waste stabilization with CKD is found at wastewater treatment plants (WWTPs) and chemical production facilities.

In addition to municipal sludge stabilization, the use of CKD to solidify oil sludge also has evoked a fair amount of interest and research.[8,9,10] According to one source, CKD has proven to be one of the most efficacious and economical means of solidifying non-recoverable

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[4] Keystone Cement Company, date unknown. *StableSorb: A Coproduct of Cement Manufacturing With a Variety of Uses*. Product Brochure.

[5] Burnham, J.C., 1988. *CKD/Lime Treatment or Municipal Sludge Cake, Alternative Methods For Microbial and Odor Control*. Paper from Proceedings of National Conference on Municipal Sewage Treatment Plant Sludge Management. June 27-29. Palm Beach, Florida.

[6] Personal communication with J. Patrick Nicholson, N-Viro Soil, December 7, 1992.

[7] Kelley, W.D., D.C. Martens, R.B. Reneau, Jr., and T.W. Simpson, 1984. *Agricultural Use of Sewage Sludge: A Literature Review*. Bulletin 143. Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. December. p. 38.

[8] Morgan, David S., *et al*., 1984. *Oil Sludge Solidification Using CKD*. Journal of Environmental Engineering. October.

[9] Thorsen, J.W., *et al*., 1983. *In Situ Stabilization and Closure of an Oily Sludge Lagoon*. 3rd Ohio Environmental Conference. March. Columbus, Ohio.

[10] Zarlinski, S.J. and J.C. Evans, 1990. *Durability Testing of a Stabilized Petroleum Sludge*. Paper from Hazardous and Industrial Wastes, Proceedings of 22nd Mid-Atlantic Industrial Waste Conference. July 24-27. Pennsylvania.

waste oil sludge, producing a stable and compactible fill material with good compressive strength. Solidification of oily sludge in landfills makes it possible to use a reclaimed landfill site for industrial construction.[11]

CKD has also been used to neutralize and stabilize some additional wastes such as acid waste, synthetic wastes, contaminated dredged materials, and non-degradable liquid hazardous wastes. Finally, CKD has been used both alone and in conjunction with other soil stabilizing agents to temporarily or permanently increase the stability of soils at locations such as construction sites. CKD has also been utilized on a limited basis to reclaim settling ponds, lagoons, and abandoned mines.

### 4.4.2 Soil Amendment (Fertilizer)

As shown in Exhibit 4-5, about 12 percent of the CKD used beneficially in 1990 was used as a soil amendment, mostly as fertilizer. Like agricultural lime, CKD is alkaline and contains a number of essential plant nutrients. Because of these parallel characteristics, CKD has been used as an agricultural soil amendment for a number of years. CKD possesses significant fertilizer potential, particularly because of its high potassium content. It has been used to this end at the state and local levels in Ohio, Illinois, and Pennsylvania, because it provides savings over substitute products.[12] Agricultural studies relating to the use of CKD as a fertilizer have been undertaken in several countries around the world, including Russia, Poland, Netherlands, Czechoslovakia, and India.

Although there has been a considerable amount of research conducted on CKD use as a fertilizer, existing applications of CKD for this purpose have been mostly anecdotal, and there is only limited evidence that commercial CKD use as a fertilizer is growing significantly.

### 4.4.3 Liming Agent

Nearly six percent of the CKD used beneficially in 1990 was used as a liming agent. CKD has significant potential as a liming agent because of its high alkalinity. Substances that can and have been neutralized with CKD include industrial acidic wastes such as spent pickle liquor, leather tanning wastes, and cotton seed delinting chemicals. CKD also has been used as an agricultural liming agent to treat acidic soils. In the mid-eighties, it was used as an agricultural lime on a regional basis in New York.[13,14]

### 4.4.4 Materials Additive

Approximately 2.7 percent of CKD used beneficially was used in 1990 for materials additive applications, where CKD is blended with cement either alone or with other additive materials and aggregates to make concrete. CKD also has been used as a mineral filler for bituminous paving materials and asphaltic roofing materials. In addition, glassmakers have used CKD in glass that does not have stringent color restrictions or requirements for chemical stability.

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[11] Morgan, David S., *et al.*, 1984. *op. cit.*

[12] Personal Communication with Marc Saffley, Soil Conservation Service (SCS), November 18, 1992.

[13] Naylor, L.M., J.C. Dagneau, and I.J. Kugelman, 1985. *CKD - A Resource Too Valuable to Waste?* Proceedings of the Seventeenth Mid-Atlantic Industrial Waste Conference on Industrial and Hazardous Wastes. June 23. pp. 353-366.

[14] Naylor, L.M., E.A. Seme, and T.J. Gallagher, 1986. *Using Industrial Wastes in Agriculture*. BioCycle. February. pp. 28-30.

#### 4.4.5 Road Base

Approximately 1.2 percent of the CKD used beneficially in 1990 was used for road base construction. CKD provides an economically attractive substitute for road base products such as fill materials and lime. Use of CKD for this purpose has, however, been limited thus far and the subject does not appear to have attracted much continuing attention.

#### 4.4.6 Other Uses

About eight percent of the CKD used beneficially in 1990 was used in other uses (e.g., wet scrubbing and general undefined agricultural use).

## CHAPTER FOUR

## CURRENT MANAGEMENT PRACTICES FOR CKD

## LIST OF EXHIBITS